

Preservation of Peri-implant Soft and Hard Tissues Using Platform Switching of Implants Placed in Immediate Extraction Sockets: A Proof-of-Concept Study with 12- to 36-month Follow-up

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Purpose: The purpose of this article is to evaluate the soft- and hard-tissue response to immediately placed implants. In addition, assessment was conducted of the soft tissue response to a transmucosal abutment which was narrower than the implant platform. **Materials and Methods:** This study was conducted to evaluate 10 consecutively placed immediately loaded implants placed in extraction sockets in maxillae without compromised bone tissue. The infection control phase of periodontal therapy was completed in the areas of hopeless teeth prior to extraction. Implants with a 6-mm-platform diameter were placed immediately into the fresh extraction sockets. A provisional 4-mm-diameter transmucosal abutment was subsequently connected, and a provisional crown was adapted and adjusted for non-functional immediate positioning. Three months following implant placement, definitive prosthetic rehabilitation was performed. At the time of prosthesis insertion (baseline) and every 6 months thereafter, radiographic assessments, pocket probing depth (PPD), recession, and papilla height were measured. An image analysis software application was used to compare the radiographic bone crestal bone heights at the mesial and distal aspects of the implants. **Results:** Nine patients with 10 sites were treated. Mean follow-up time was 22 months (range, 18 to 36 months). All 10 implants were found to be clinically osseointegrated. Software analysis of radiographic films showed a bone resorption of 0.78 ± 0.36 mm. The mean values were significantly lower ($P \leq .005$) than a mean reference value of 1.7 mm. PPD did not exceed 3 mm in any site (average, 2.8 mm). Rather than recession, there was a mean gain in the buccal margin of 0.2 mm and a mean gain in papilla height of 0.25 mm. **Conclusion:** This proof-of-concept study suggests that immediate loading with platform switching can provide peri-implant hard tissue stability with soft tissue and papilla preservation. (Case Series) INT J ORAL MAXILLOFAC IMPLANTS 2007;22:995-1000

Key words: dental implants, immediate implants, immediate loading, platform switching, marginal bone loss

A predictable esthetic result can prove difficult to achieve when an extracted tooth must be replaced with an implant in the anterior maxilla. Research has demonstrated that, for 2-stage implants, marginal bone loss primarily occurs during the first year following loading.^{1,2} Authors³⁻⁵ have attributed bone loss to the generation of a biologic width adjacent to the implant.

Bone remodeling occurs at a specific distance from the microgap at the implant-abutment interface. Some studies have shown that the bone remodel-

ing can be biologically ascribed to the bacterial colonization of microleakage present in a 2-stage implant system and subsequent inflammation.⁶⁻⁸ Typically, about 1.72 mm of bone is resorbed approximately 6 months after implant placement.^{9,10} Studies have also demonstrated the overall buccal resorption of hard and soft tissues after tooth extraction.^{11,12} These physiologic events can be detrimental to the esthetic results. Immediate implant placement has been suggested to avoid bone collapse^{12,13}; however, placement after abutment connection can result in the re-establishment of biologic width and lead to unesthetic results.¹⁴

The aim of this case series was to evaluate the changes in radiographic bone levels from the time of implant placement to 18 to 36 months after definitive prosthetic rehabilitation in cases where implants were immediately loaded following tooth extraction.

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Fig 1 (left) Preoperative view of a hopeless tooth.

Fig 2 (right) Fresh extraction site without flap reflection: buccal bone mapping to test the facial bone wall presence.

An additional aim of this study was to investigate the soft and hard tissue response in cases where the abutment diameter was smaller than the implant platform (platform switching).

MATERIALS AND METHODS

In 10 cases, a hopeless tooth was extracted, and an implant was placed in the extraction socket and immediately loaded. All participants signed an informed consent form prior to enrollment in this study. Inclusion criteria included a suitable postextraction site, the presence of a wide bone ridge (ie, no need for a bone regeneration procedure), and absence of infection (Fig 1). Patients with teeth with acute infection; a Full Mouth Plaque Score and a Full Mouth Bleeding Score greater than 25%¹⁵; interproximal and buccal bone defects; a smoking habit of more than 10 cigarettes per day; or uncontrolled diabetes were excluded. Women who were pregnant or lactating were also excluded.

Surgical Protocol

Patients were treated prophylactically with 2 g penicillin and clavulanic acid (Augmentin 1 g; GlaxoSmith Kline, Verona, Italy) 1 hour prior to surgery and continued to receive 2 g per day postoperatively for 6 days. In all 10 cases, the extractions were performed atraumatically (ie, without raising a flap) using a periosteal elevator to avoid damage to the alveolar socket (Fig 2). The fresh postextraction sites were thoroughly debrided. TSATM Series 5 Defcon implants (Defcon Implant System, Barcelona, Spain) 13 mm long were inserted according to protocol for implants immediately loaded postextraction.¹⁶ This type of implant possesses threads with reverse buttress, a smooth neck surface of 1.7 mm in height, and a platform of 6 mm.

The edge of the implant platform was placed at the level of the labial bony wall. In each case adequate primary implant stability was achieved (initial torque of 32 to 45 Ncm). If the distance between the implant and the bony wall was greater than 1 mm, the gap was filled with a mixture of bovine bone

matrix (Bio-Oss; Geistlich Biomaterials, Wolhusen, Switzerland) and blood.^{17,18}

In each patient, a provisional abutment with a diameter of 4 mm (2 mm narrower in diameter than the implant platform) was inserted (20 Ncm). Customized provisional crown restorations were then counterformed for optimal marginal fit. In addition, emergence profiles and interproximal contacts were measured and recorded. Occlusal centric and eccentric contacts were not permitted on the provisional restorations. Such contacts were detected using a 200- μ m articulating paper. Thereafter, the provisional restorations were bonded with an antiseptic gel (Corsodyl; GlaxoSmithKline, Verona, Italy).

For each site, mesial and distal soft tissue dimensions and buccal peri-implant mucosa levels were measured from a tangent created from the incisal edges or occlusal surfaces of adjacent teeth, recorded to the nearest 1 mm (Fig 3),¹⁹ and used as a baseline. The dimensions of the peri-implant mucosa were also recorded.²⁰ Digital periapical standardized radiographs using a parallel technique were obtained at baseline (Fig 4).

Patients were instructed to function on a soft diet and to avoid mastication in the treated area for at least 8 weeks, as immediate loading protocols suggest for single-implant restorations.²¹ Oral hygiene was limited to soft brushing in the surgical site for the first 2 weeks, with regular brushing in the rest of the mouth and a rinse of 0.12% chlorhexidine gluconate. Thereafter, conventional brushing and flossing were permitted. After 1 week, sutures were removed, and the provisional crown was cemented temporarily (Temp Bond; KerrHawe, Boggio, Switzerland).

Three to 4 months later, an impression was made for each patient, and the soft peri-implant tissue was examined for signs of inflammation (Fig 5). A TSA Series 4 coping transfer (Defcon Implant System) was used. The coping transfer was modified to avoid a collapse of the mucosa over the implant collar.

In each patient, a zirconium abutment (zirconzhan, Bozen, Italy) with a diameter of 4 mm and a ceramic crown (zirconzhan) were used for the definitive restoration (Fig 6). Crowns were constructed to



Fig 3 Mesial, facial, and distal soft tissue dimensions were measured from the tangent created by the incisal edge or occlusal surfaces of adjacent teeth at the time of provisional prosthesis placement, definitive restoration placement, and every follow-up examination.



Fig 4 Periapical radiograph obtained after temporary crown insertion. A series 5 TSA implant (6 mm platform) was placed and primary stability was achieved. A series 4 temporary abutment (4 mm diameter) was then screwed in.



Fig 5 Implant site before pickup impression. No signs of inflammation are detectable.



Fig 6a A definitive metal-free prosthetic restoration in place.



Fig 6b Radiograph at the time of abutment insertion.



Fig 6c Radiograph at the time of definitive crown insertion.

match the contours and contact areas of the contralateral teeth as closely as possible to allow optimal adaptation of the soft tissue. Restorations were not modified to fill in voids in the soft tissue.

At the definitive abutment and crown connection, pocket probing depth (PPD), recession, and papilla height were remeasured. Furthermore, all radiographic assessments of bone resorption around implants were recorded (Fig 6b).

Follow-up Implant Evaluations

Every 6 months, patients were reassessed to evaluate periodontal parameters and soft tissue adaptation (PPD, recession, gingival height). The aggregate measurements were compared to the baseline measurements. All assessments were conducted by an independent examiner.

Radiographic Evaluation

Every 6 months, standardized periapical digital radiographs of all patients were obtained to compare bony changes after loading to baseline measure-

ments. The peri-implant marginal changes were evaluated with a computerized measuring technique. The distances from both the mesial and distal margins of the implant collar to the most coronal point where the bone appeared to be in contact with the implant were measured by an independent examiner. Image analysis software with the ability to compensate for radiographic distortion (Scion Image 4.02 Win; Scion, Frederick, MD) was used.

Mean values and standard deviations (ie, the data distribution) were graphed with box plots. Several reports have investigated the amount of peri-implant bone remodeling, over time, around 2-stage dental implants in cases of standard delayed or immediate loading.²²⁻²⁵ Based on this research, the statistician for the present article used 1.7 mm as the literature reference value (the best control available) to better underline the significance of the present results. The Student *t* test was selected to compare the mean values of mesial and distal measurements to this reference value. The level of statistical significance was set at $P \leq .005$.

Table 1 Summary of Included Cases

Patient	Gender	Implant no.	Biotype	Age (y)	Implant position*	Date of implant insertion	Date of definitive restoration	Bone level change from baseline (mm)		PPD (mm)			Papilla level compared to baseline (mm)		Level of recession (mm)	
								Mesial	Distal	M	B	D	P	Mesial		Distal
1	F	1	Thin	55	12(24)	26 Jul 02	03 Nov 02	0.772	0.998	3	3	3	3	+1	0	0
2	F	2	Thick	549	5(14)	13 Nov 02	10 Feb 03	0.390	0.250	3	3	3	3	+1	+1	+1
3	F	3	Thick	34	23(11)	15 Feb 04	22 May 04	0.632	1.387	3	2	2	3	0	0	0
4	F	4	Thick		10(22)			1.020	1.590	3	2	3	3	0	0	0
5	F	5	Thin	46	23(11)	12 Mar 04	20 Jun 04	0.002	0.230	3	2	3	3	0	0	0
6	F	6	Thick	33	13(25)	15 Mar 04	21 Jun 04	0.706	1.334	3	3	3	3	+1	0	+1
7	M	7	Thick	38	13(25)	20 Mar 04	25 Jun 04	0.741	1.592	3	3	3	2	0	0	0
8	F	8	Thick	41	4(15)	05 Apr 04	01 Jul 04	0.320	1.011	2	3	3	3	+1	0	0
9	F	9	Thin	46	5(14)	11 Apr 04	01 Jul 04	0.552	0.792	3	2	3	3	0	0	0
10	M	10	Thick	69	10(23)	30 Apr 04	02 Jul 04	0.563	0.891	3	2	3	3	0	0	0

*Universal (FDI).

RESULTS

From September 2002 to December 2005, 9 consecutive patients (2 men and 7 women) with 10 hopeless teeth in the anterior maxilla without any compromising bone tissue were included in this study (Table 1). At the time of implant insertion, the patients ranged in age from 33 to 69 years (mean age, 45.9 years). All patients were in good general health. No patient dropped out over the course of the study. The mean follow-up time was 21.9 months (range, 18 to 36 months). The 10 implants replaced 3 maxillary incisors, 1 maxillary canine, and 6 maxillary premolars. All implants were clinically osseointegrated, stable, and showed no signs of infection.

Average Radiographic Bone Loss

The postoperative radiographs demonstrated an average bone loss of 0.57 mm on mesial surfaces (range, 0.002 to 1.02 mm), and 1.01 mm on distal surfaces (range, 0.230 to 1.592 mm; Table 1). Overall mean bone loss was 0.78 ± 0.36 (Table 1).

No substantial differences were found in radiographic periodic controls (Fig 7a).

Periodontal Parameters

Bleeding upon probing was not detected in any patient, and PPD did not exceed 3 mm (mean 2.8 mm; Table 1). Absence of inflammatory signs in the inner peri-implant soft tissues was verified at the time of impression making.

Esthetic Parameters

The soft tissue anatomy was clinically acceptable to all patients, and additional mucogingival surgery was considered unnecessary. Interproximal papillae showed no apical migration (Table 1). A slightly increased papillary level was noticed in some cases (Fig 7b); mean papilla height gain was 0.25 mm. The buccal margin did not show any perceptible change; in fact, when recession was examined, a mean gain of 0.2 mm was observed.

DISCUSSION

In this case series, a 2-stage implant system was used in conjunction with platform switching to improve and maintain both osseous and soft tissue levels associated with immediately loaded implants placed in extraction sockets. Several studies have investigated the amount of peri-implant bone remodeling around 2-stage dental implants loaded after a standard delay compared with those loaded immediately.²²⁻²⁴ The variation in resorption between these 2 groups has ranged from 1.72 mm to 3.00 mm.

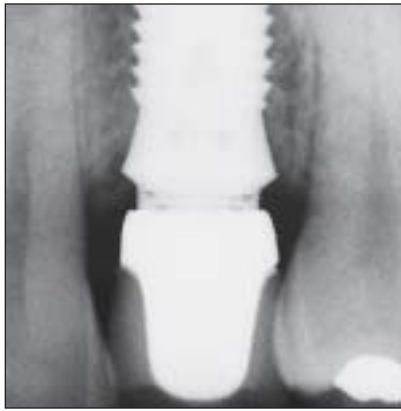


Fig 7a Radiograph after 36-month follow-up. The marginal bone is stable. Greater mineralization can be observed compared to the previous periapical radiographs (Figs 6b and 6c).



Fig 7b Coronal gain of the interdental papillae after the 36-month follow-up.

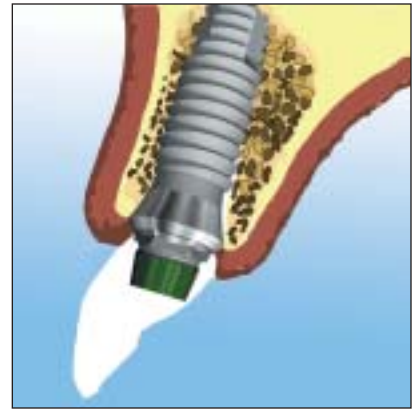


Fig 8 In the implant restored with the platform-switching concept, the biologic width extends 1 mm horizontally from the abutment to the edge of the collar of the implant, and the remainder extends apically to the neck of the implant.

In this work, the platform-switching technique (from 6 to 4 mm) was used; after 18 to 36 months of follow-up, the mean bone resorption was 0.78 mm. The bone resorption data in this study were slightly lower than the mean values of bone resorption reported in literature²⁵; however, some studies have shown higher bone loss around implants in the anterior maxilla. These findings might be explained by the biologic width formed near the implant-abutment interface, which may be attributable to the microgap located at the edge of the interface. With the platform-switching protocol, the biologic width extends 1 mm horizontally from the abutment to the edge of the collar of the implant, and the remainder extends apically to this region (Fig 8), which should facilitate bone preservation.

Moreover, crestal bone loss between the follow-up and baseline measurements was imperceptible radiographically; this may be attributable to slightly faster tissue maturation of the cases described. Hard and soft tissue preservation may be attributable to the use of deproteinized bovine bone to fill the gap between the implant surface and the facial bony walls where necessary. The levels of crestal bone loss in the present study appear slightly lower than results described in literature,²⁵ given that bone resorption was calculated using baseline measurements made immediately after connection of the definitive prosthesis. The results of this paper are also in line with the observations of Lazzara and Porter.²⁶ This recently published study included long-term radiographic follow-up of platform-switched restored wide-diameter dental implants demonstrating less vertical change than expected in the crestal bone

height around implants (ie, less than that typically observed around implants restored conventionally with prosthetic components of matching diameters).

There was good soft tissue healing around the immediate implants in the present study. Maintenance of papillae and buccal margin levels were consistently observed. Sometimes coronal displacement was even seen in cases with a longer follow-up. Biotype (thick or thin) did not seem to influence the final esthetic, clinical, or radiographic outcomes. The results of this case series are in accordance with the previous literature on soft tissue changes around single implants^{19,27} as well as reported data on platform switching.²⁶ The consistency may be ascribed to the microinvasive extraction technique and the bone-preserving implant placement procedure used.

The short-term survival rate for the cases reported was high, and the esthetic results were excellent. However, these results may have been influenced by the small number of patients, the relatively short functional period, and the rigorous periodontal and prosthetic monitoring. Additional parameters contributing to the success of this protocol include primary implant stability (implant placement torque of 32 to 45 N) and nonfunctional loading during the postextraction healing period.

CONCLUSION

This report shows a clinical case series of immediately loaded implants placed in extraction sockets with an 18- to 36-month follow-up period. These preliminary results suggest that, in postextractive imme-

mediate loading implant procedures, platform switching can preserve soft and hard tissues and, therefore, may provide better esthetic outcomes.

The radiographic observations suggest that the postrestorative biologic process, which typically results in the loss of crestal bone height, is altered when the outer edge of the implant-abutment interface is horizontally repositioned inwardly, away from the outer edge of the implant platform.

The treatment protocol described in this study has been reliable with patients who had infection-free postextraction sites and a wide ridge of bone not requiring guided bone regeneration. Furthermore, it was reliable in conjunction with initial implant stability and nonfunctional loading during the postextraction healing period.

Further clinical and histologic studies will be required to obtain additional data regarding the affect of the height of the implant collar and the presence of a rough surface. Longitudinal evaluation of the stability of the previously described implant-abutment connection is also needed.

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